

ASTRONOMY– PHYSICS, B.A.

ASTRONOMY

Astronomy, the oldest of the sciences, originated in the human urge to understand the mysterious lights we see in the sky above us—the Sun, the Moon, the planets and the stars. Over the centuries, new tools have become available to study these cosmic icons—telescopes that allow us to see further and fainter, detectors that are sensitive to electromagnetic signals at non-visible wavelengths, and satellites that can observe from outside the confines of the Earth’s atmosphere. These tools have answered many questions, but raised even more. How did the Universe begin, and how did the stars and galaxies within it form? How will it end? Are there habitable planets around other stars—and has life emerged on these planets?

WHY STUDY ASTRONOMY?

- Because it’s fascinating: Astronomy speaks directly to our natural urge to better understand our place in the cosmos.
- Because it’s challenging: Astronomy studies objects that are distant beyond simple conception.
- Because it’s adaptable: Astronomy utilizes a broad set of transferable skills, from a foundation in logical and quantitative reasoning through to data analysis, programming, and visualization.

The UW–Madison Astronomy–Physics program builds on a foundation of classical and modern physics, to embark on a comprehensive study of the observable Universe at scales extending from planets and stars, through to galaxies and the cosmic web.

A BACHELORS DEGREE FROM THIS STEM PROGRAM CAN:

- Prepare you for graduate studies for master’s or doctoral degrees in experimental or theoretical Astronomy, Astrophysics or Physics.
- Prepare you for employment in industrial or governmental laboratories.
- Provide a broad background for further work in other sciences, such as materials sciences, aerospace, computer science, geophysics, meteorology, radiology, medicine, biophysics, engineering, and environmental studies.
- Provide a science-oriented liberal education. This training can be useful in some areas of business administration, public policy, law, or other fields where a basic knowledge of science is useful.
- Provide part of the preparation you need to teach Astronomy and Physics. To teach these subjects in high school, you will also take education courses to become certified. You will need a doctoral degree to become a college or university professor.

Students who intend to continue astronomy in a graduate program are strongly encouraged to get involved in research early. To learn about research opportunities in the department, please meet with faculty advisors. Please consider applying for Research Experiences for Undergraduates (REU’s) and if interested in department research, visit our webpage (<https://www.astro.wisc.edu/undergraduate-program/current-students/>) and reach out to individual faculty. On our webpage you will find our Undergraduate Student Handbook as well as some of the current research projects.

HOW TO GET IN

Students who wish to declare the Astronomy–Physics may do so after arriving at UW–Madison (students cannot declare this major as part of their UW–Madison admissions process).

Students are encouraged to declare their major as early as their first year. For pre-major and major advising, students should contact the undergraduate advisor or faculty advisors.

Astronomy–Physics Majors should get started on one of the Introductory Physics sequences as early as possible.

Introductory Physics sequences are:

| Code | Title | Credits |
|-------------|---------------------------|---------|
| Sequence 1: | PHYSICS 247, 248, and 249 | |
| Sequence 2: | PHYSICS 201, 202, and 205 | |
| Sequence 3: | PHYSICS 207, 208, and 241 | |

REQUIREMENTS

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (<http://guide.wisc.edu/undergraduate/#requirementsforundergraduatestudytext>) section of the *Guide*.

| General Education | Requirements |
|-------------------|---|
| | • Breadth–Humanities/Literature/Arts: 6 credits |
| | • Breadth–Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits |
| | • Breadth–Social Studies: 3 credits |
| | • Communication Part A & Part B * |
| | • Ethnic Studies * |
| | • Quantitative Reasoning Part A & Part B * |

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

COLLEGE OF LETTERS & SCIENCE DEGREE REQUIREMENTS: BACHELOR OF ARTS (B.A.)

Students pursuing a bachelor of arts degree in the College of Letters & Science must complete all of the requirements below. The College of

Letters & Science allows this major to be paired with either a bachelor of arts or a bachelor of science curriculum.

BACHELOR OF ARTS DEGREE REQUIREMENTS

Mathematics Complete the University General Education Requirements for Quantitative Reasoning A (QR-A) and Quantitative Reasoning B (QR-B) coursework.

Foreign Language

- Complete the fourth unit of a foreign language; OR
- Complete the third unit of a foreign language and the second unit of an additional foreign language.

L&S Breadth

- 12 credits of Humanities, which must include 6 credits of literature; and
- 12 credits of Social Science; and
- 12 credits of Natural Science, which must include one 3+ credit Biological Science course and one 3+ credit Physical Science course.

Liberal Arts and Science Coursework Complete at least 108 credits.

Depth of Intermediate/Advanced work Complete at least 60 credits at the intermediate or advanced level.

Major Declare and complete at least one major.

Total Credits Complete at least 120 credits.

UW–Madison Experience

- 30 credits in residence, overall; and
- 30 credits in residence after the 86th credit.

Quality of Work

- 2.000 in all coursework at UW–Madison
- 2.000 in Intermediate/Advanced level coursework at UW–Madison

NON–L&S STUDENTS PURSUING AN L&S MAJOR

Non–L&S students who have permission from their school/college to pursue an additional major within L&S only need to fulfill the major requirements. They do not need to complete the L&S Degree Requirements above.

REQUIREMENTS FOR THE MAJOR

The major requires a minimum of 34 credits in the field of specialization, with at least 6 of these credits in ASTRON and at least 28 credits in PHYSICS.

COURSE REQUIREMENTS FOR THE MAJOR ARE:

| Code | Title | Credits |
|---|-----------------------------------|---------|
| Astronomy¹ | | |
| Complete at least two of the following: | | 6 |
| ASTRON 310 | Stellar Astrophysics ² | |
| ASTRON 320 | The Interstellar Medium | |
| ASTRON 330 | Galaxies ² | |
| ASTRON 335 | Cosmology ² | |

ASTRON 340 Solar System Astrophysics

ASTRON 500 Techniques of Modern Observational Astrophysics²

Physics

Complete one of the following sequences for Introductory Physics:³ 28

Sequence 1:

PHYSICS 247 & PHYSICS 248 & PHYSICS 249 A Modern Introduction to Physics and A Modern Introduction to Physics and A Modern Introduction to Physics

Sequence 2:

PHYSICS 201 & PHYSICS 202 & PHYSICS 205 General Physics and General Physics and Modern Physics for Engineers

Sequence 3:

PHYSICS 207 & PHYSICS 208 & PHYSICS 241 General Physics and General Physics and Introduction to Modern Physics

Mechanics, Electromagnetic Fields, & Thermal Physics (complete all):

PHYSICS 311 Mechanics

PHYSICS 322 Electromagnetic Fields

PHYSICS 415 Thermal Physics

Atomic & Quantum Physics (complete either):

PHYSICS 448 & PHYSICS 449 Atomic and Quantum Physics and Atomic and Quantum Physics

or

PHYSICS 531 Introduction to Quantum Mechanics

Complete one 300-level or higher laboratory course:

ASTRON 465 Observational Astronomy and Data Analysis

PHYSICS 307 Intermediate Laboratory–Mechanics and Modern Physics

Additional PHYSICS to reach minimum of 28 credits

Total Credits

34

RESIDENCE AND QUALITY OF WORK

- 2.000 GPA in all ASTRON, all PHYSICS, and all major courses
- 2.000 GPA on 15 upper-level major credits in residence⁴
- 15 credits in ASTRON and PHYSICS, taken on campus

HONORS IN THE MAJOR

Students may declare Honors in the Major in consultation with the Astronomy–Physics undergraduate advisor(s). Please plan your Senior Honors Thesis research project a year in advance.

HONORS IN THE MAJOR REQUIREMENTS

To earn Honors in the Major, students must satisfy both the requirements for the major (above) and the following additional requirements:

- Earn a 3.300 University GPA
- Earn a 3.500 GPA for all ASTRON and PHYSICS courses, and all courses accepted in the major, at the 300 level or higher
- Complete the following coursework:
 - Four 300-level or higher ASTRON courses, with a 3.500 GPA (not including ASTRON 681 and ASTRON 682)
 - A two-semester Senior Honors Thesis in ASTRON 681 and ASTRON 682, with a grade of AB or better (for a total of 6 credits).

6. Develop the skills to carry out a small independent research project. Learn to define the scope of the project, conduct an effective literature search, perform computations, and analyze data.

FOOTNOTES

1

ASTRON 103 and ASTRON 104 are not required for majors.

2

ASTRON 310 is a prerequisite for ASTRON 330, ASTRON 335, and ASTRON 500.

3

E M A 201, E M A 202, and M E 240 count toward the 28 credits of PHYSICS requirement. E M A 201 & E M A 202, or E M A 201 & M E 240 count as a first semester, introductory course (e.g., PHYSICS 247, PHYSICS 201, PHYSICS 207).

4

ASTRON 300-699 and PHYSICS 300-699 are upper-level in the major.

UNIVERSITY DEGREE REQUIREMENTS

Total Degree To receive a bachelor's degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.

Residency Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. "In residence" means on the UW–Madison campus with an undergraduate degree classification. "In residence" credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.

Quality of Work Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

LEARNING OUTCOMES

1. Learn how astronomical observations are made and data are analyzed.
2. Become familiar with theories and observations of planets, stars, interstellar gas, galaxies, and structure of the Universe (cosmology).
3. Learn how to read and critically evaluate scientific literature.
4. Learn the basics of oral and written scientific communication.
5. Be trained in principles and standards of professional and ethical conduct.

FOUR-YEAR PLAN

SAMPLE FOUR-YEAR PLAN

This Sample Four-Year Plan is a tool to assist students and their advisor(s). Students should use it—along with their DARS report, the Degree Planner, and Course Search & Enroll tools—to make their own four-year plan based on their placement scores, credit for transferred courses and approved examinations, and individual interests. As students become involved in athletics, honors, research, student organizations, study abroad, volunteer experiences, and/or work, they might adjust the order of their courses to accommodate these experiences. Students will likely revise their own four-year plan several times during college.

First Year

| Fall | Credits | Spring | Credits |
|------------------------------|-----------|--------------------------------|-----------|
| MATH 221 (QR-B) | | 5 MATH 222 | 4 |
| Biological Science Breadth | | 3 Biological Science Breadth | 3 |
| Humanities Breadth | | 3 Social Science Breadth | 3 |
| Foreign Language (if needed) | | 4 Foreign Language (if needed) | 4 |
| | | Communication A | 2 |
| | 15 | | 16 |

Second Year

| Fall | Credits | Spring | Credits |
|------------------------------|-----------|----------------------------|-----------|
| PHYSICS 247, 201, or 207 | | 5 PHYSICS 248, 202, or 208 | 5 |
| MATH 234 | | 4 Literature Breadth | 3 |
| ASTRON 200 | | 3 Social Science Breadth | 4 |
| Foreign Language (if needed) | | 4 MATH 320 ¹ | 3 |
| | 16 | | 15 |

Third Year

| Fall | Credits | Spring | Credits |
|--------------------------|-----------|---|-----------|
| PHYSICS 249, 205, or 241 | | 4 PHYSICS 311 | 3 |
| ASTRON 310 | | 3 ASTRON 320 (or another ASTRON 300 level course) | 3 |
| MATH 321 ² | | 3 MATH 322 ² | 3 |
| Communication B | | 3 PHYSICS 322 | 3 |
| | | Literature Breadth | 3 |
| | 13 | | 15 |

Fourth Year

| Fall | Credits | Spring | Credits |
|------------------------|---------|--------------------------|---------|
| PHYSICS 448 | | 3 Social Science Breadth | 3 |
| ASTRON 465 | | 3 PHYSICS 449 | 3 |
| Social Science Breadth | | 3 PHYSICS 415 | 3 |
| Ethnic Studies | | 3 Humanities Breadth | 3 |

| | | |
|-----------|--------------------------------------|-----------|
| Elective | 3 Astronomy 300 Level OR Elective | 3 |
| 15 | | 15 |

Total Credits 120

1

Alternatively, students may wish to consider MATH 319 and MATH 340.

2

Students are encouraged to consider MATH 321 and MATH 322 for additional preparation prior to coursework completed in the fourth year of this plan.

ADVISING AND CAREERS

ADVISING

We encourage students to meet major advisors as early as possible. For major advising, students should contact the Undergraduate Advisor (<https://www.astro.wisc.edu/undergraduate-program/current-students/#preliminary-and-career-advising>). The undergraduate advisor (via Starfish) can assist students with curriculum and course scheduling, career planning, academic concerns, and overall performance and strategies.

To declare the astronomy–physics major, **first** meet with the undergraduate advisor, then contact the faculty Advisors: Professor Ke Zhang (ke.zhang@wisc.edu (townsend@astro.wisc.edu)) or Professor Snezana Stanimirovic, (ssstanimi@astro.wisc.edu).

RECOMMENDED ADDITIONAL COURSES

Math: Mathematics courses other than those required as prerequisites for PHYSICS courses are not required for the major, but the following courses are recommended: MATH 320 Linear Algebra and Differential Equations OR MATH 319 Techniques in Ordinary Differential Equations and MATH 340 Elementary Matrix and Linear Algebra. If a student plans to work toward the Ph.D degree, the student should also take MATH 321 Applied Mathematical Analysis and MATH 322 Applied Mathematical Analysis. Additional mathematics (or statistics) courses should be chosen after consultation with the undergraduate advisor.

Computing: Computers are fundamental to astronomical research. An introduction through Introduction to Programming, or short courses run by the computing center should be considered. COMP SCI 220 Data Science Programming I is a good option.

Chemistry: A college course in physical or organic chemistry is useful for astronomy students. Physical chemistry is particularly valuable for those interested in the interstellar medium, comets, and planets.

Statistics: A background in statistics is valuable, particularly for students interested in observational astronomy. STAT 302 Accelerated Introduction to Statistical Methods, or STAT/MATH 309 Introduction to Probability and Mathematical Statistics I/STAT/MATH 310 Introduction to Probability and Mathematical Statistics II for a more solid foundation, are suggested.

Languages: Spanish but also, French, German and Russian are also useful foreign languages for astronomy students, but are not required.

L&S CAREER RESOURCES

Every L&S major opens a world of possibilities. SuccessWorks (<https://successworks.wisc.edu/>) at the College of Letters & Science helps students turn the academic skills learned in their major, certificates, and other coursework into fulfilling lives after graduation, whether that means jobs, public service, graduate school or other career pursuits.

In addition to providing basic support like resume reviews and interview practice, SuccessWorks offers ways to explore interests and build career skills from their very first semester/term at UW all the way through graduation and beyond.

Students can explore careers in one-on-one advising, try out different career paths, complete internships, prepare for the job search and/or graduate school applications, and connect with supportive alumni and even employers in the fields that inspire them.

- SuccessWorks (<https://careers.ls.wisc.edu/>)
- Set up a career advising appointment (<https://successworks.wisc.edu/make-an-appointment/>)
- Enroll in a Career Course (<https://successworks.wisc.edu/career-courses/>) - a great idea for first- and second-year students:
 - INTER-LS 210 L&S Career Development: Taking Initiative (1 credit)
 - INTER-LS 215 Communicating About Careers (3 credits, fulfills Comm B General Education Requirement)
- Learn about internships and internship funding (<https://successworks.wisc.edu/finding-a-job-or-internship/>)
 - INTER-LS 260 Internship in the Liberal Arts and Sciences
- Activate your Handshake account (<https://successworks.wisc.edu/handshake/>) to apply for jobs and internships from 200,000+ employers recruiting UW-Madison students
- Learn about the impact SuccessWorks has on students' lives (<https://successworks.wisc.edu/about/mission/>)

PEOPLE

Faculty:

Professors Richard Townsend (chair), Amy Barger, Thomas Beatty, Matt Bershady, Elena D'Onghia, Kate Grier, Sebastian Heinz, Alex Lazarian, Michael Maseda, Bob Mathieu, Snezana Stanimirovic, Christy Tremonti, Susanna Widicus Weaver, Eric Wilcots, Ke Zhang, and Ellen Zweibel

Staff:

Department Administrator: Steve Anderson
 Graduate Program Manager: Heather Sauer
 Research Administrator: Sophia Didier
 Building Manager and Purchasing: Rick Williams

See preliminary and career advising (<https://www.astro.wisc.edu/undergraduate-program/current-students/#preliminary-and-career-advising>) for academic advising information.